Energy Fridays 12/05/2023

ENI - Magnetic Fusion Initiatives

Antonio Trotta
ENI IN BRIEF

ENI’S MISSION

We are an energy company.

We concretely support a just energy transition, with the objective of preserving our planet

And promoting an efficient and sustainable Access to energy for all.

Our work is based on passion and innovation, on our unique strength and skills,
on the equal dignity of each person, recognising diversity as a key value for human development,
on the responsibility, integrity and transparency of our actions.

We believe in the value of long term partnerships with the countries and communities where we operate bringing long-lasting prosperity for all.

ENI’S GLOBAL PRESENCE

69 COUNTRIES OF PRESENCE

32,000 ENI PEOPLE*

10,000 ENI PEOPLE ABROAD

85% AVERAGE PRESENCE OF LOCAL EMPLOYEES ABROAD

* Eni SpA & consolidated subsidiaries

Figures at 31 December 2021
ENI’S ORGANIZATIONAL STRUCTURE

SUPPORT FUNCTIONS

TECHNOLOGY, R&D & DIGITAL

NATURAL RESOURCES

ENERGY EVOLUTION

OIL, GAS, LNG, AGRI-FEEDSTOCK, CCUS, CARBON OFFSET

TRADITIONAL TO BIO, BLUE, GREEN PRODUCTS

TO BE A LEADER IN THE ENERGY TRANSITION
ENI DISTINCTIVE APPROACH | Delivering value through the transition

**NEW BUSINESS MODELS**
- matching business growth with dedicated leadership team and capital structure
- LEANER & FIT
- GROWTH & VALUE-ORIENTED

**STAKEHOLDER ALLIANCES**
- partnering and jointly contributing to an inclusive transition
- OUR PEOPLE
- CUSTOMERS
- INDUSTRIES
- CITIZENS

**PROPRIETARY AND BREAKTHROUGH TECHNOLOGIES**
- expanding a diversified portfolio of decarbonized products
- LEADING EDGE
- COMPETITIVE
- BUILDING SCALE
ENI DECARBONIZATION STRATEGY: TOWARDS A NET ZERO ENERGY BUSINESS BY 2050

A COMPACT FUSION ENERGY POWER PLANT COMMERCIALY EXPLOITABLE

< 15 years

Eni Commitment in De-carbonization
- Zero carbon emission by 2050
- Sustainable energy

Short & Mid-Term Strategy
- Renewable, bio-masses, bio-fuel, hydrogen, CCS (Carbon Capture & Storage), circular economy

Long Term Strategy
- Magnetic confinement fusion
  - Breakthrough technologies
  - Risk management through validation of innovative technologies

BREAKTHROUGH TECHNOLOGY FOR A CLEAN AND RELIABLE ENERGY
MFI organization

MAFID - Magnetic Fusion Industrial Development
MAFE - Magnetic Fusion Technologies Development
MFID - Magnetic Fusion Initiatives Development
ENI FUSION ACTIVITIES ALONG

**TECHNOLOGY DEVELOPMENT**

Main Activities on innovative technologies:
- Tritium
- System Integration
- Power electronics
- Plasma Physics
- Molten Salts
- Magnets/Quench
- Materials
- Safety
- Diagnostics

Eni Team Directly Involved in:
- Development of Enabling & Innovative technologies
- Engineering and Construction
- Project Management, Procurement, Market aspects

Development of studies on:
- Fusion Energy Scenarios
- Fusion Supply Chain

Eni Fusion Program
- 50+ people engaged
- Aspects covered: CFS; DTT; technology Monitoring; Industrial development Models; Stakeholders; Communications; HSE; Supply Chain & Italian ecosystem

Engagement with 5+ Fusion Agencies & Associations

**INDUSTRIAL DEVELOPMENT**

**BUSINESS DEVELOPMENT**
Eni & MIT activated LIFT projects: R&D to accelerate and “de-risk” the path towards ARC

From SPARC to ARC:
a path towards industrial application

Eni joined ENEA in the Limited Liability Cooperative DTT (Divertor Tokamak Test Facility) contributing to the project with its own project engineering skills for the development of a fusion plant

Eni created a JRC with CNR for:
- Basic research
- Advanced Modeling
- Development of local skills through the activation of research and doctoral scholarships.

THE 3 PILLARS FOR FUSION ENERGY DEVELOPMENT IN ENI

1. CFS/MIT

OBJECTIVE: ARC REALIZATION FOR POWER GENERATION ON A CONTINUOUS BASIS (Q>>1)

2. DTT

OBJECTIVE: CONSTRUCTION & OPERATION OF THE DTT TO MANAGE THERMAL LOAD

3. Joint Research Center Eni-CNR

OBJECTIVE: DEVELOPMENT OF "KNOW HOW" ON FUSION ENERGY
Eni investment in CFS → 3 phase fast-track approach to the first commercial compact high field tokamak

### 2018
- **Phase 1:** 20T HTS magnetic field reached

### 2021
- **Phase 2:** SPARC First experimental tokamak for technology demonstration Q > 1

### 2025
- **Phase 3:** ARC first demonstration fusion power plant

ENI WAS THE FIRST MOVER IN THE ENERGY INDUSTRY
LIFT Program
Laboratories for Innovation in Fusion Technology

LIFT PROJECTS

Materials
HTS Magnets
Molten Salt Blanket
Tritium
RF Plasma Heating
LIFT Projects for Accelerating the Development of ARC

Tritium Inventory
- LIFT #10 - Separation of He from D-T

Molten Salt Blanket
- LIFT #4 - Molten salt fluid dynamics in high B field
- LIFT #5 - FLiBe blanket validation plan
- Support to LIBRA project

Materials for Fusion
- LIFT #2 - Intermediate energy ions for material damage
- LIFT #7 - Nanocomposite structural materials
- LIFT #8 – Molten Salt Radiation decelerated corrosion
- LIFT #9 - Rapid ARC structural and first wall bulk material down-selection
- NEW LIFT (cont. lift # 11-9-8-3-2) – Q1 23

Vacuum Vessel & FW
- LIFT #3 - Ultra-thin liquid first wall surfaces
- LIFT #11 - Liquid Sandwich Vacuum Vessel

Physics
- NEW Lift Disruption Q4 22
- NEW Lift Divertor Modelling Q4 22

HTS Magnets
- LIFT #1 - ReBCo radiation damage
- LIFT #12 - Cryogenic Irradiation of HTS
- NEW LIFT – Mcubed Q4 22

Lift #6: Advanced Radio Frequency
Eni entered the DTT project in 2019 with a share of 25%. Eni is involved in DTT by means of:

- internal resources directly seconded or assigned to the project
- engineering services throughout qualified suppliers
- R&D services provided throughout the major Italian universities (PoliMI, PoliTO, UniPD ...) & excellence R&D centres (CNR).

**PROJECT MANAGEMENT INCLUDING**

- Legal & procurement (support)
- HSE, occupational safety & risk analysis, radiation protection
- QA & QC

**INNOVATIVE TECHNOLOGIES DEVELOPMENT AND VALORIZATION**

**SYSTEM INTEGRATION INCLUDING**

- Technical office responsibilities
- System requirements & Interface management
- Novelties management: identification & follow-up
- Site layout & permitting
- CODAS & PCS
## ENI Main Activities in the DTT Project

### TOKAMAK HALL (WBS TKM)
- Toroidal Field (TF), Poloidal Field (PF) & Central Solenoid (CS) magnets
  - Design & engineering activities (support)
  - Technical documentation for tenders
  - Follow-up of suppliers
- TF & PF magnets power supply
  - Design & engineering activities (support)
  - Technical documentation for tenders
  - Follow-up of suppliers
- Internal Vessel Coils (IVC) power supply
  - Design & engineering activities up to tender documentation (support)
  - Follow-up of suppliers
- Remote Handling System (RHS) for In-Vessel components
  - Responsibility of design & engineering activities
  - Design & engineering activities including kinematic models, reachability analysis, interface with other subsystems ...

### HEATING & CURRENT DRIVE (WBS HCD)
- ECH launcher & control system (support)
- ICH transmitter & control system (support)

### BALANCE OF PLANTS (WBS BOP)
- New BUILDings (BUI)
- Refurbishment & revamping of existing BUI
- AUXiliary plant project (AUX)
- Electrical Distribution System (EDS)
- Control Safety Security Telecom Systems (AUT)
DTT Secondees & MAFID People dedicated to the project

Balance of Plant

Costruzione

Innovative Technologies

Tokamak Responsible Officers

Sistemi ausiliari

Project Management

System integration
We are coming...
THANKS – Q&A SESSION
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Images and video are courtesy of CFS/MIT/DTT and JET